

Patent Claims

- 5 1. A vertical drawing method for producing a cylindrical glass body, particularly of quartz glass, comprising continuously feeding a glass cylinder to a heating zone having a vertically oriented heating tube, adjusting the longitudinal cylinder axis of the glass cylinder relative to the longitudinal axis of the heating tube, zonewise softening the glass cylinder, drawing a glass
- 10 strand from the softened glass cylinder, and cutting the glass strand to size to obtain the cylindrical glass body, characterized in that the adjusting operation comprises sensing a value for a first radial xy-position of the longitudinal cylinder axis (16) of the glass cylinder (4) in a first horizontal sensing plane (E1), drawing the glass cylinder (4) arranged in the first xy-
- 15 position into a test glass strand (10), and carrying out the following method steps once or repeatedly:
- a) measuring an actual state of a radial circular or annular dimension of the test glass strand,
 - 20 d) determining a deviation between the actual state and a desired state of the circular or annular dimension with respect to its size and position in consideration of the position of the glass cylinder (4) relative to the inner wall of the heating tube (1) during drawing,
 - e) calculating a corrected xy-position of the longitudinal cylinder axis (16) on the basis of a correction factor (K) and the size and position of the deviation,
 - 25 d) installing the glass cylinder (4) in the heating tube (1) such that the longitudinal cylinder axis (16) extends at least in the first horizontal sensing plane (E1) in the corrected xy-position, and
 - 30 e) drawing the glass cylinder (4) installed in the corrected xy-position to obtain a further test glass strand (10).

2. The method according to claim 1, characterized in that the sensing of the value for the first radial xy-position comprises producing an optical image of the glass cylinder (4) in the first sensing plane (E1) and at least part of the heating tube (1) or a calibration body (5a, 5b) in stationary relation with the heating tube (1), and evaluating the optical image.
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3. The method according to claim 1 or 2, characterized in that a tubular test glass strand (10) is drawn.
- 10 4. The method according to claim 3, characterized in that the measurement according to method step a) comprises measuring the wall thickness extension of the tubular test glass strand (10).
- 15 5. The method according to any one of claims 3 or 4, characterized in that a tubular test glass strand (10) is drawn with an outer diameter of not more than 50 mm, preferably between 10 mm and 20 mm.
- 20 6. The method according any one of the preceding claims, characterized in that the measurement according to method step a) is carried out during drawing, the circular or annular dimension being determined at a plurality of measurement points distributed over the circumference of the test glass strand (10).
- 25 7. The method according to any one of the preceding claims, characterized in that the measurement according to method step a) is carried out on pieces of the test glass strand (10) that have been cut to length, using a stationary wall thickness measuring device.

8. The method according to any one of the preceding claims, characterized in that in a tubular test glass strand (10) a distance A between the xy-position and the corrected xy-position is calculated on the basis of the following dimensioning rule:

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$$A = K \times \text{wall one-sidedness}$$

where K is a correction factor ranging between 5 and 40 if the wall one-sidedness is indicated as the differential amount between the maximum value and the minimum value of the wall thickness.

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9. The method according to any one of the preceding claims, characterized in that a value is determined for the first radial xy-position of the longitudinal cylinder axis of the glass cylinder (4) in a second horizontal sensing plane (E2) which extends spaced apart from the first sensing plane (E1).

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10. The method according to any one of the preceding claims, characterized in that installing the glass cylinder (4) according to method step d) comprises computer-controlled transportation of the glass cylinder (4) to the corrected xy-position.

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11. The method according to any one of the preceding claims, characterized in that a glass cylinder (4) consisting of test material is used.

12. An apparatus for producing a cylindrical glass body by means of a vertical drawing method, comprising a heating zone which includes a vertically oriented heating tube, and an adjusting means for adjusting the longitudinal cylinder axis of a glass cylinder (4) to be drawn relative to the longitudinal axis of the heating tube, characterized in that the adjusting means comprises:
- a) a sensing means (6, 7, 6b, 7b) for sensing a value for a first radial xy-position of the longitudinal cylinder axis (16) of the glass cylinder (4) in a first horizontal sensing plane (E1),
 - b) a measuring means (11, 12) for measuring an actual state of a radial circular or annular dimension of a test glass strand (10) drawn from the glass cylinder (4),
 - c) a microprocessor (8) for determining a deviation between the actual state and a desired state of the circular or annular dimension with respect to its size and position in consideration of the position of the glass cylinder (4) relative to the inner wall of the heating tube (1) during drawing, and for calculating a corrected xy-position of the longitudinal cylinder axis (16) inside the heating tube (1) on the basis of a correction factor (K) and the size and position of the deviation,
 - d) and a displacement means (14) by which the glass cylinder (4) is installed in the heating tube (1) such that the longitudinal cylinder axis (16) extends at least in the first horizontal sensing plane (E1) in the xy-position.
13. The apparatus according to claim 12, characterized in that the sensing means comprises a first optical sensing means (6, 7) for producing an optical image of the glass cylinder (4) in the first sensing plane (E1) and at least a part of the heating tube (1) or a calibration body (5a, 5b) which is in stationary relationship with the heating tube (1).

14. The apparatus according to claim 13, characterized in that the first sensing means (6, 7) comprises a first camera and a second camera, each being arranged in the first sensing plane (E1) such that the respective viewing direction thereof extends in a direction perpendicular to the longitudinal cylinder axis (16).
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15. The apparatus according to claim 14, characterized in that the sensing means comprises a second optical sensing means (6b, 7b) with a third camera and a fourth camera, each being arranged in a second sensing plane (2) extending spaced apart from the first sensing plane (E1), in such a manner that the respective viewing direction thereof extends in a direction perpendicular to the longitudinal cylinder axis (16).
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16. The apparatus according to any one of claims 12 to 15, characterized in that the measuring means comprises a plurality of wall thickness measuring devices distributed over the circumference of the test glass strand (10).
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17. The apparatus according to any one of claims 12 to 15, characterized in that the measuring means comprises a wall thickness measuring device (11; 12) which is rotatable about the outer circumference of the test glass strand (10).
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